

FACTS



Ministry
of the
Environment

M. Gordon
Ontario

Hon. George A. Kerr, Q.C.
Minister

K. H. Sharpe
Deputy Minister

FACTS ABOUT THE OPERATION OF A PULP AND PAPER MILL: ITS USES AND EFFECTS ON A RIVER

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INTRODUCTION

The world's forests provide one of the most valuable natural resources: Wood. The tree, apart from providing shelter and challenges for young people, is the basic ingredient for pulp, packaging, and thousands of other products -- right down to the paper this Fact Sheet is written on.

Canada is one of the foremost producers of pulp and paper products. The industry is a significant contributor to the country's economy. Being an export nation, Canada sells 50 per cent of the value of goods and services it produces abroad. About 80 per cent of the pulp and paper produced in Canada is exported. Of the total exports, paper products account for approximately 20 per cent. The pulp and paper industry also plays an important role in the economy of Ontario, especially in the north. In 11 towns in Northern Ontario, the pulp and paper industry employs over 50 per cent of the total labor force. And in many of these towns, it is the only source of employment.

Since each mill produces a specific product from a particular wood species, the environmental problem and hence its solution is peculiar to that mill. If the mill closes, it would have a severe impact on the social fabric of the town. This social and technical aspect of the industry requires sensible enforcement of environmental policies. But, on the other hand, unlike coal and oil, trees are a renewable resource and for that reason we can expect the pulp and paper industry to be an integral part of our society for years to come, which makes it even more important that environmental standards are met. However, the environment is affected at almost every stage of the pulp and paper process, from the procurement of wood to the production of paper.

PROCUREMENT OF WOOD

As large volumes of water are used in the production of pulp and paper, mills are normally located near a lake or river. The river is occasionally used for the movement of raw wood to the mill and also provides the mill with clean water for its processes, approximately 30 to 40 million gallons for every 1,000 tons of product.

Changes in water quality of rivers used for transporting logs to the mill have been reported. This practice has changed the water quality in three basic ways. First, the phenolic components in the river have reportedly risen, probably because of the extractable components leaching from the logs. Secondly, bark and other debris have been found deposited on the bottom of the river. Lastly, there is user conflict, in that when the river is full of logs it makes it almost impossible for canoeing and swimming. Fortunately, there are only two rivers presently being used for transporting wood to the mill in Ontario.

Wood is delivered to a pulping mill as either chips or roundwood. Chips are used directly in thermal mechanical pulp mills and chemical pulping mills. Whereas the roundwood, full length tree and the tree cut to four foot lengths, must first be subjected to a preparation process. It is in this process that the tree is cut to length, debarked and either stored or sent to the next stage of processing.

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DEBARKING

Log debarking is necessary to meet product quality. Dry and wet bark removal methods are in common use. The bark is knocked off the logs by a tumbling action within large drums called debarkers. The bark and wash water then is sluiced to drainers or screens where the bark is recovered for burning as a fuel. The effluent, high in suspended solids from the drainers, is sent by the mill sewers to a clarifier for removal of the solids. In recent years there has been a trend toward dry debarking. In dry debarking, very little water is used to carry away the bark and the system can be closed so that no effluent is discharged.

After debarking, the log is reduced to wood chips generally 1/2 to 3/4 inches in size. This permits rapid penetration of the cooking liquor into the wood during chemical pulping.

The bark removed from the wood represents a major disposal problem at most mills. Acceptable disposal methods include incineration for heat generation, landfill, and utilization as filler in building board.

Bark and other wood residue from sawmills are burned at most pulp mills. These represent inexpensive, low quality fuels that can be burned either alone or in conjunction with oil, coal, or gas. Bark from a dry debarking operation, because of its low moisture content is a desirable fuel, while bark from wet debarking requires mechanical pressing to remove excess water. There has been, in recent years, a great deal of innovation in conserving energy within the pulp and paper industry. New methods for burning bark are being introduced; one, the fluidized-bed combustion system which approaches the thermal efficiency of oil burning, creates heat for steam generation and at the same time emits minimal pollution.

Landfilling of the wood residues is becoming less and less popular. The primary problem is the potential contamination of the freshwater in the vicinity of the landfill site.

Most companies do not have a use for bark in a product, but are investigating alternative uses. One use for it, which appears to be applicable, is a particular grade of building board. Manufacturers have found that they can produce an acceptable product with as much as 25 per cent bark. Another use is in the manufacture of soil conditioners and mulch by the composting of bark.

PROCESSING

The primary purpose of pulping is to separate the fibre from the lignin as it exists in wood. Once in the separated state, fibre then can be converted into sheet form. Pulping is achieved through the application of either mechanical energy or chemical energy.

Lignin, the second most abundant component of wood, accounting for 25 to 35 per cent by weight, is usually a part of the effluent contributing to the pollutive aspects of the pulping process.

There are basically four methods used to make pulp: groundwood, kraft, sulphite and thermal mechanical. Thermal mechanical is being viewed as a possible solution to environmental problems created by sulphite mills. The sulphite process contributes to over half of the biological oxygen demand contamination of the total pulp making industry.

GROUNDWOOD

In the groundwood mill approximately 94 per cent of the wood is recovered as pulp. To reduce the wood to pulp, the wood is pressed against large grindstones driven by electric motors to rip the wood apart, releasing the fibre bundles into the grinder channel (an open pipe running underneath the grinder for accepting the pulp). From here the pulp is screened and the rejects are recycled except for knots and slivers, which are sent either to landfill, the sewer, or the bark boiler. Most groundwood mills are integrated with a sulphite mill to produce newsprint (75 per cent groundwood and 25 per cent sulphite). This pulp is not as strong as that from chemical pulping but has qualities useful for high-speed printing (newsprint).

KRAFT AND SULPHITE

Chemical pulp is prepared either in a sulphite mill or a kraft mill. The pulp yield ranges from 50 to 75 per cent of the wood. Chemical pulping releases the cellulose fibres by dissolving the lignin and other non-cellulose constituents in the wood. Sulphite and kraft mills produce fibre with different characteristics. The sulphite mill uses acidic based cooking liquor and is limited to certain species of trees.

The kraft process is now the most popular process in use. Its versatility and flexibility make it suitable for use with any wood species. Extractives of certain wood species, which led to pitch troubles in acid sulphite pulping, are dissolved or dispersed by the alkaline liquor. The rapidity of the process and the high strength properties of its pulp are further advantages. One of the principal drawbacks relate to the dark color of virgin kraft pulp and this may be corrected by bleaching. Innovations are constantly being introduced at the bleaching stage to reduce the effluent problem. The effluent from the bleaching stage is rich in dissolved organics and is brown in color. In a Canadian design complete closure of this stage has been accomplished allowing no pulping effluent to be discharged from the mill. A new kraft mill incorporating this design has been built in Thunder Bay and is being "debugged".

Kraft pulping, utilizing an alkaline solution referred to as white liquor composed of sodium sulphide and sodium hydroxide, delignifies the wood during the fibre separation. The spent cooking liquors, following digestion or cooking, are separated from the pulp and treated in the kraft recovery system. Spill collection systems have been added at some mills so that all the cooking liquors can be re-claimed. The recovery system regenerates the cooking chemicals, while utilizing the heat value of the organic residue to generate steam for power and process. There are a number of organic by-products such as turpentine and tall oil, recovered from kraft pulping liquors.

With two exceptions, sulphite pulping mills in Ontario do not have chemical recovery systems and thus in most cases the spent cooking liquor is sewered.

THERMAL MECHANICAL

In thermal mechanical pulping, a fairly new process, chips are steamed prior to refining. Steaming, for a short duration, is designed to soften the chips prior to being processed in the refiner. The first refiner also operates under steam pressure and elevated temperatures to help in the breakdown of the fibres from the wood.

The pulp is then re-refined in a secondary refiner which may or may not be steam pressurized before final screening and centri-cleaning and preparation for use in the paper mill. The full environmental impact of these new pulping operations have not yet been completely determined, but it is anticipated that the biochemical oxygen demand and dissolved solids loading will be significantly lower than from the sulphite process, but higher than from the groundwood process.

At this time, thermal mechanical pulping is being considered for the future as the primary process for newsprint production. There are thermal mechanical mills already in operation in Scandinavia and the United States producing newsprint. Many of the old sulphite mills in these countries have been replaced by an expansion of a kraft mill or by a thermal mechanical mill to meet environmental requirements. At Kapuskasing there is a 200 ton per day thermal mechanical pulping mill.

ENVIRONMENTAL EFFECTS

WATER

As have been shown, the major contributors to water pollution from the pulp mills are suspended solids and dissolved organic compounds. Dissolved organic compounds include such things as sugars, organic acids, and alcohols. The biochemical oxygen demand test which is conducted over five days (BOD5) indicates the effect of these effluents on the water and natural life. Another test used to determine the effects of the dissolved organic compounds on the water and natural life is the dissolved solids test which is conducted over a two-hour period. Essentially, what occurs is the dissolved organic compounds use up oxygen when they decompose. If the receiving water course is small relative to the mill effluent, the ultimate result is the suffocation of fish. Although that is the most drastic effect, there are residual effects that are very difficult to ascertain because of their complexities. Water has the inherent ability to assimilate the BOD5 contamination, where the problem occurs is when the life cycles of the aquatic world are interrupted or affected.

Mills used to discharge wastewaters with a high solid waste content to the river and large quantities of bark and fibrous material were usually evident downstream of a pulp mill operation. In many cases, there was no clarifier. However, every Ontario mill has in the last 10 years, installed facilities to reduce suspended solids. With time, these deposits will be flushed out. Within the near future dissolved solids and oxygen demanding compounds in the effluent will also be reduced by every mill prior to leaving the plant.

The major source for suspended solids is the wood room, the paper machine and the process where the pulp is cleaned and screened. The kraft and sulphite mills are responsible for the majority of the biochemical oxygen demand. However, it has been shown that a sulphite mill can discharge up to 800 pounds of biochemical oxygen demand per ton of product, whereas a kraft mill has a load of approximately 60 pounds of BOD5 per ton of product. But if, a chemical recovery system and other refinements were installed in a sulphite mill, the effluent would be similar to that of a kraft mill.

Research has been done to identify compounds that have a toxic effect on fish. In some cases, acute toxicity occurs, where within 30 minutes to four hours an exposed fish would die. The purpose behind this research is to identify the process source from where the toxic effluent originates so corrective measures can be instigated. Complications arise when fish suffer residual effects, such as an unusual smell and taste: alcohol, for example, is one compound that has this effect on fish.

Adequate dissolved oxygen levels are essential to fish and other aquatic life. For fish, dissolved oxygen requirements must be adequately provided for egg development, for the newly hatched young, and for normal growth and development through the later life stages.

One survey conducted on a mill and river, showed that depressed oxygen levels in the .05 to 3 ppm range were evident downstream of the mill to the mouth of the river, an estimated distance of 45 miles. Large accumulations of bark and wood fibre, deposits of up to six feet in depth, were observed along the river course. Floating bark mats were observed as well as dead fish.

There was also evidence of gas being generated from decomposing bottom sediments. The effects of the mill's effluent were obvious.

AIR

Air emissions in the wood pulping industry can be primarily attributed to the two chemical processes, kraft and sulphite. Significant air emissions from the wood pulping operation are particulate matter, sulphur dioxide and odourous compounds, commonly referred to as total reduced sulphur compounds (TRS).

The kraft process is a major source of TRS and particulate air emissions and may be a significant source of some sulphur dioxide air emissions. The TRS emissions which are associated with kraft mills consist mainly of hydrogen sulphide, methyl mercaptan, dimethyl sulphide, and dimethyl disulfide. These TRS compounds are troublesome because of their disagreeable odour and low threshold odour level. However, using the best available technology in 1977, a new kraft mill can be designed and operated so that most of the odour is kept to the mill site.

In both processes, major emissions occur when the digesters are discharged at the end of the pulping period. Significant emissions may also occur from the absorption tower in the sulphite process. In a kraft mill, depending on the recovery furnace design, a higher sulphur dioxide emission may occur in comparison to a TRS or odour emission. Air emissions from the mechanical pulping process can be considered insignificant.

Burning of bark and other organic waste is becoming more widespread as energy costs increase and other disposal methods become unsatisfactory because of space requirements or water pollution. Combination boilers, burning woodwaste and other fuel, are widely used for steam production in many pulp and lumber mills. Emissions of particulate from these units can be significant unless controlled.

CORRECTIVE MEASURES

SOLIDS

There are essentially two approaches available for the abatement of polluting effluents from pulp and paper mills, internal and external abatement facilities. Examples of internal techniques range from dry debarking, which doesn't have any effluent going into the river, rather the bark is controlled and disposed of at a landfill site, to the paper machine which also can be closed so that no effluent be discharged.

The installation of clarifiers is considered essential as an external first stage method for removing suspended solids. A mechanical clarifier will usually remove between 70 to 90 per cent of the solids. With the addition of a poly-electrolyte flocculant to the clarifier the removal will improve. A clarifier can be applied at different stages in a mill, it can be used in the barkroom, so the water could be reused for the same purpose, or it could be used to remove undesirable grit from lime mud, or it can be used on the total effluent from a mill.

BOD5

To reduce the biochemical oxygen demand, two forms of treatment are commonly used. An internal change in the process can be introduced, for example, steam stripping hot condensates from the process resulting in warm non-toxic water which can be reused. The stripped volatiles are odourous and are incinerated. Another innovation is the new highly efficient pulp washer, that can collect up to 90 per cent of the cooking chemicals, the original washers may have only recovered 80 per cent. Chemicals

are required in every method of making paper, in some cases chemicals can be re-cycled, but not always because reused chemicals may detract from the quality of paper being produced. An external method is a secondary biological treatment similar to what municipalities use, an example of this is a lagoon where the effluent is stored while it is treated by exposing it to oxygen through the use of mechanical aerators. There are a number of difficulties in maintaining an effective secondary biological treatment. The micro-organisms, that work to assimilate the organic compounds, require ideal conditions of constant temperatures and a steady food supply of nutrients. Fertilizer, urea, may be added in some cases as food. In an efficient treatment plant as high as 70 to 85 per cent of the BOD can be removed.

TOXIC EFFECTS

Effluents discharged from a mill have been documented to be high in suspended and dissolved solids. There has been considerable concern expressed regarding the effects of toxic effluent from pulp and paper mills on the aquatic population and receiving streams. Some organics being discharged from these mills have been shown to have toxic characteristics. Specific waste streams, such as wet debarking effluent, condensates, spent cooking liquor, and bleach plant wastes have been demonstrated to be toxic to fish.

This Ministry and Environment Canada have pioneered in developing toxicity tests on fish and furnished research funds to identify toxicity sources in a mill. Besides the 96-hour test, they have developed several shorter tests. The federal legal toxicity test defines fish toxicity as: "An effluent is considered to be toxic when less than 80 per cent of the fish population survive for 96 hours when exposed to an aerated and circulating solution of mill effluent. Concentration to be standard for this investigation is to be 65 per cent on a volume for volume basis of freshwater".

AIR EMISSIONS

Air abatement technology, using the add-on approach, has been amply developed. Scrubbers, cyclones, baghouses, and electrostatic precipitators are used to collect particulate. Odourous compounds are incinerated or chemically scrubbed.

CONCLUSION

Pollution from pulp and paper mills can only be overcome by the expenditure of considerable sums of money for the installation of abatement and updated processing equipment. It is the responsibility of those charged with ensuring that pollution abatement does take place, that environmental problems of the future are reduced to a minimum so that the rivers and lakes serving the Provinces' pulp and paper industries are environmentally acceptable and useable by all residents -- human, animal, and aquatic.

For each use of water there are certain water quality characteristics, identified as criteria, which should be met to ensure that the water is suitable for that use. The Ministry of the Environment has published Guidelines and Criteria for Water Quality Management in Ontario. One of these guidelines is that all wastes prior to discharge must receive the best practicable treatment or control. Such treatment must be adequate to protect and wherever possible upgrade water quality in the face of population and industrial growth, urbanization, and technological change.